

**CLAIMS**

What is claimed is:

1. A plant comprising an absorber that receives a feed gas at a pressure of at least 400 psig and comprising at least 5 mol% carbon dioxide, wherein the absorber is operated at an isothermal or decreasing top-to-bottom thermal gradient, and wherein the absorber employs a physical solvent to at least partially remove an acid gas from the feed gas.
2. The plant of claim 1 wherein the absorber produces a semi-rich solvent and a rich solvent, and wherein the semi-rich solvent is cooled by at least partially expanded rich solvent.
3. The plant of claim 1 wherein the absorber produces a rich solvent that is expanded in at least two steps, wherein expansion in one step produces work, and wherein expansion in another step provides refrigeration for at least one of a semi-rich solvent produced by the absorber and a carbon dioxide product.
4. The plant of claim 1 wherein the absorber produces a rich solvent that is expanded in at least three steps, wherein expansion in the at least three steps produces at least three recycle streams, respectively, and wherein the at least three recycle streams are fed into the absorber.
5. The plant of claim 4 wherein the at least three recycle streams are compressed to form a compressed recycle stream, and wherein further refrigeration is provided by Joule-Thomson cooling of compressed recycle stream.
6. The plant of claim 1 wherein the feed gas is cooled by at least partially expanded rich solvent.
7. The plant of claim 6 wherein the feed gas is further cooled by an absorber overhead product.
8. The plant of claim 1 wherein at least part of the acid gas is removed from the physical solvent at a pressure of between about 1 psia to 10 psia.

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9. The plant of claim 1 wherein the feed gas has a pressure between about 400 psig to about 3000 psig, and wherein the feed gas is at least partially dehydrated.
10. The plant of claim 1 wherein the feed gas has an acid gas content of between about 10 mol% to about 75 mol%.
11. The plant of claim 1 wherein the feed gas comprises natural gas.
12. The plant of claim 1 wherein the absorber is operated at a bottom temperature of about -25°F to about -45°F.
13. The plant of claim 1 wherein the absorber produces a rich solvent that is expanded to provide refrigeration for a carbon dioxide product.
14. The plant of claim 1 wherein the feed gas has a pressure of at least 1000 psig, and wherein at least a portion of the acid gas in the feed gas is removed from the feed gas using a membrane separator.
15. A plant comprising:
  - an absorber that receives a natural gas comprising at least 5 mol% acid gas and having a pressure of at least 400 psig;
  - a physical solvent that absorbs at least a portion of the acid gas in the absorber to form a semi-rich solvent;
  - a cooler fluidly coupled to the absorber that receives and cools the semi-rich solvent and provides the cooled semi-rich solvent back to the absorber, wherein the cooled semi-rich solvent further absorbs at least another portion of the acid gas to form a rich solvent; and
  - wherein the natural gas and the semi-rich solvent are cooled at least in part by expansion of the rich solvent.

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16. The plant of claim 15 wherein the cooling of the natural gas and the semi-rich solvent provides an isothermal or decreasing top-to-bottom thermal gradient in the absorber.
17. The plant of claim 15 wherein expansion of the rich solvent provides at least one hydrocarbon containing recycle stream, and wherein the at least one hydrocarbon containing recycle stream is fed back to the absorber.
18. The plant of claim 17 wherein the at least one recycle stream is compressed to form a compressed recycle stream, and wherein further refrigeration is provided by Joule-Thomson cooling of compressed recycle stream.
19. The plant of claim 17 wherein further expansion of the rich solvent liberates at least a portion of the acid gas from the solvent, and wherein further vacuum stripping at a pressure of about 1 psia to about 10 psia produces a lean solvent.
20. The plant of claim 15 wherein the natural gas has a pressure of at least about 1000 psig, and wherein at least a portion of the acid gas in the natural gas is removed from the natural gas using a membrane separator.
21. The plant of claim 1 wherein a hydrocarbon liquid stream is formed on a discharge of a recycle gas cooler, wherein the hydrocarbon liquid stream can be recovered as a liquid product while reducing an amount of recycle gas.
22. The plant of claim 17 wherein a hydrocarbon liquid stream is formed on a discharge of a recycle gas cooler, wherein the hydrocarbon liquid stream can be recovered as a liquid product while reducing an amount of recycle gas.